



**Third United Nations
International Conference
on the Peaceful Uses
of Atomic Energy**

A/CONF.28/A/605
SWEDEN

February 1964

Original: ENGLISH

Confidential until official release during Conference

Abstract

A Large Swedish Nuclear Power Station with a Pressurized Heavy Water
Reactor with an Open Uniform Lattice Core.

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The work presented here covers a study carried out of a nuclear power plant capable of being built today in Sweden using Swedish resources. The major design effort was initiated at the beginning of 1962 in the belief that only by carrying out a design based on realistic conditions would it be possible to raise serious interest among the potential power plant operators.

The plant is designed in accordance with Swedish practice and with full regard to Swedish conditions, and has a net output of 350 MW in a one-reactor two-turbine installation. The general plant design resembles closely a PWR type plant in that it utilizes a pressure vessel reactor with multiple steam generator loops feeding the turbine plant with saturated steam.

It has been found throughout the design of the entire station that the characteristics of the uniform lattice open core give a plant where simplicity of equipment and ease of operation combine with strong inherent safety features to give a low capital cost. The use of D_2O gives the additional advantage of a low enrichment fuel cycle offering the possibilities of operation ranging from natural uranium fuel through the "once through, throw away" U-235 cycle to the U-nat feed plutonium cycle.

The use of fuel rod clusters in guide tubes or pressure tubes has been avoided by distributing the fuel rods in a uniform lattice over the entire core cross-section. This configuration, which leads to an intimate contact between moderator and coolant gives, in conjunction with the volume ratios dictated by the use

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of D_2O , many important advantages when compared with all other water reactor cores.

A virtual absence of hot channel factors combined with the low form factors inherent in the use of D_2O allows the mean thermal loading of the fuel to be set at a value considerably higher than is normal in water cores. The use of an open core with D_2O also means that there is no practical limitation imposed on the core due to burn-out risks. The physics of the core is such that with UO_2 enriched to 1.5 % U-235 in Zr-canning it is possible to achieve a mean discharge burn-up of about 15 000 Mwd /ton U. Operation is possible at a reduced power level with natural UO_2 and in a self-sustaining Pu-recycle mode of operation a burn-up of 9 000 Mwd/ton U is possible.

The study has been taken to a point where price tenders have been obtained for all components and installations, giving a realistic background to the judgement that this type of reactor can be a serious competitor for coming nuclear stations to be commissioned in the early 1970's. It is anticipated that future simplification in plant equipment, with consequent improvements in economy, is possible by exploiting to a greater degree than at present the unique characteristics of the uniform lattice open core pressurized heavy water reactor.